High-order azimuthal wavenumber asymmetries in rapidly intensifying Hurricane Michael (2018)

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Hurricane Michael (2018) was observed with high temporal and spatial resolution by coastal Doppler radar as the tropical cyclone (TC) rapidly intensified during its approach to Florida, collecting unique data on the structural evolution of one of the strongest TCs to ever make U.S. landfall. The hurricane eyewall showed evidence of azimuthal asymmetries from wavenumber 1 - 6 during rapid intensification, with evolving polygonal shapes evident in the radar reflectivity. While polygonal eyewall structures have been previously observed in radar and satellite imagery, the corresponding evolution of wind asymmetries are very difficult to quantitatively estimate due to both spatial and temporal sampling limitations. A single-Doppler wind retrieval with the Generalized Velocity Track Display (GVTD) technique is used to analyze the axisymmetric and asymmetric kinematic evolution at 5-minute intervals. The analysis shows quantitative evidence of growing high-order wavenumber structures in the tangential wind field that suggest the presence of rapidly-evolving vortex Rossby waves (VRWs) on an amplifying mean radial vorticity gradient. A spectral time decomposition of the GVTD winds indicates that the azimuthal propagation speeds of the VRWs are roughly consistent with linear wave theory. While both the reflectivity and wind field show evidence of high-order structure they do not propagate together, suggesting that divergence asymmetries are not fully coupled to the vorticity asymmetries. Implications of the results for improved understanding of rapid intensification will be discussed.